INFORMATION SHEET ON DEHYDRATED SWEETPOTATOES*

Western Regional Research Laboratory, Albany, California
Bureau of Agricultural and Industrial Chemistry
Agricultural Research Administration
U. S. Department of Agriculture

Production

Sweetpotatoes rank next to white potatoes in importance as material for dehydration, and are an important crop in the Southern and in the Middle Atlantic States. In 1942 707,000 acres of sweetpotatoes were harvested. Georgia, with 100,000 acres, or 14 percent of the total, ranked first in acreage harvested, as well as in total production.

Sweetpotatoes are not as widely grown as white potatoes. The 1942 production of 1.8 million tons was only one-sixth as much as the white-potato production in that year. In the years 1930-39 the combined production of nine southern States, which led all other States, averaged 1.6 million tons or 90 percent of the total. The harvesting of this crop extends from as early as June to August in Georgia, and from as late as September to November in many of the other sweetpotato-growing States. The average yield per acre for all States was 2.5 tons in 1942.

Varieties

Both the soft "yam" varieties and the hard starchy varieties are suitable for drying. The products, however, are different, and mixtures of the two types should not be made. A large number of varieties of sweetpotatoes are grown, but those that are of commercial importance are less than a dozen in number, and of these not more than 4 or 5 are of importance in any one district. Nancy Hall, Porto Rico, and Southern Queen are the chief varieties in the South. In New Jersey, Maryland, Missouri, and Kansas, members of the Jersey group--Big Stem Jersey, Maryland Golden, Red Jersey, Yellow Jersey, Orange Little Stem, and Vineland Bush--are of chief importance.

These varieties are not equal in suitability for dehydration, and because of varietal differences as well as difference in soil and climatic conditions, tests should be made prior to the establishment of a plant in a given area, to determine (1) the operating conditions that make the best dried product, (2) the acceptability of the product, and (3) the yield of dried product obtainable from the material.

Storage

Sweetpotatoes require special handling to prevent loss during storage. Only well-matured stock should be used, and it should be cured for 10 to 14 days at temperatures of 80° to 85°F. with relative humidities of 85 to 90 percent. This may necessitate the use of artificial heat. After curing, the temperature is allowed to drop to about 55°F. with relative humidity of 75 to 80 percent. Short periods of less than 50°F. will do no harm, but low temperature of long duration may cause

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* Supersedes Information Sheet ACE-169

certain types of decay, frequently characterized by the formation of dark spots which may show in the raw material or may develop only during the dehydration process. Prolonged storage of sweetpotatoes causes deterioration of the raw stock, with a resulting poor quality of the finished product when dehydrated. Slatted crates, bushel baskets, or shallow bins are used for storage. The roots should be handled as little as possible while stored.

Preparation

Sweetpotatoes are first washed and then steamed for 10 minutes to facilitate peeling. Following washing, grading to size should be performed if abrasion peeling is used, since grading results in considerably reduced waste. Abrasive peelers cause a heavy loss when used on either raw or steamed sweetpotatoes; the waste in peeling and trimming will run from 15 to 30 percent for sound material. Hand or lye peeling can be used with considerable reduction in losses.

The sweetpotatoes can be cut into slices, cubes, or strips. Immediately after cutting, the pieces must be washed thoroughly by strong sprays of clean cold water in order to remove starch from the cut surfaces. If not blanched immediately, the cut material must be kept under running cold water or in a 2 percent salt solution. For material on which this treatment has not proved effective the use of a 1 to [illegible] percent citric acid solution has been recommended. Citric acid is not, however, readily available. In any case, the material should not be held for more than one hour before blanching.

If the sweetpotatoes are to be riced or powdered, they are practically precooked before they are dried. To make the riced product, the sweetpotatoes are given the same preliminary treatment as white potatoes, except that instead of being cut in pieces, the whole tubers are steamed until thoroughly cooked. The cooked product is then passed through a ricing device having holes not over 1/8 inch in diameter. If the ricing is done while the potatoes are hot, there is less tendency for the strings to stick together on the trays or drying surface. The strings should fall from the ricer to the drying surface.

Blanching

Sweetpotatoes should be blanched as soon as possible after they are peeled and cut. Blanching in steam is recommended. The time must be adjusted to allow the complete destruction of the peroxidase system, which requires 6 to 10 minutes. It is essential to avoid all contact with iron during blanching. Failure to observe this precaution will result in blackening of the product. A suggested blancher loading is 1-1/2 to 2 pounds per square foot of loading surface. The maximum delay allowable between blanching and dehydration is one hour.

Dehydration

The moisture content of raw sweetpotatoes varies with the variety, maturity, locality, and storage conditions. Since moisture content influences the yield of dry product, it is important for the operator to know the moisture content of the material to be used. The approximate range in moisture content of raw sweetpotatoes is shown below,

at the left. From these percentages the weight, in pounds, of water in sweetpotatoes per pound of "bone-dry" matter has been calculated and is shown also. The bone-dry matter must not be confused with the finished product, which contains a low percentage of moisture, as shown by the maximum percentage permitted under government specifications. The ratio of water to bone-dry matter in the raw product is useful to the operator because it shows him how much water is contained in the product and makes readily calculable the weight of water that must be removed.

Moisture in raw sweetpotatoes (percent)*		Lbs. water per lb. bone-dry matter		Moisture specification (maximum percent)
Range	Av.	Range	Av.	
58.5-82.7	68.5	1.4-4.8	2.2	7.0

* From Chatfield and Adams: Proximate composition of fresh vegetables. U.S.D.A. Circular 146 (1931). Tests at the Western Regional Research Laboratory have shown higher average ratios of water to bone-dry matter--3.0 instead of 2.2 to 1.

The drying ratio, or its converse, the drying yield, can be calculated from the change in moisture content of the material in the drying step alone. The drying ratio is the ratio of the weight of material entering the dehydrator to the weight of the same material as it leaves the dehydrator commercially dry. The drying yield, usually expressed in percentage, is the reverse ratio of the same two weights. These ratios are useful in the design of dehydrators and for comparing the prospective yields of product from different types of raw material, since it may usually be assumed without serious error that the moisture content of the prepared blanched material entering the dehydrator is the same as that of the raw vegetable. The following values of drying ratio and drying yield were calculated in that way from the moisture ranges given in the foregoing table, assuming the moisture content of the commercially dry product to be 7 percent:

Drying ratio, lbs. entering dehydrator per lb. leaving it at 7 percent moisture		Drying yield, percent	
Range	Av.	Range	Av.
2.2-5.3	2.9*	18.6-44.6	33.8*

* The drying ratio and yield corresponding to the average moisture content of sweetpotatoes observed in tests at the Western Regional Research Laboratory (3 pounds per pound bone-dry) are 3.74 to 1, and 26.7 percent respectively.

The operator is more directly interested in the overall shrinkage ratio, which is the weight of unprepared raw product required to yield one pound of finished product that meets specifications. This may also be expressed as the reversed ratio, usually as a percentage, and is then known as the overall yield. The overall shrinkage ratio is always substantially higher than the drying ratio, and the overall yield lower than the drying yield, because all weight losses incurred at various steps of the process, such as culling, washing, peeling, trimming, and inspecting, must be discounted. Averages and ranges are not included here, because these other losses vary widely, as shown under "Preparation" on page 2.

For the dehydration of riced sweetpotatoes, slices, cubes, and strips, the following tray loadings for different systems of air flow are suggested for trial:

Type of piece	Gross circulation of air	Through circulation of air	Finishing bin
	Lbs. per sq. ft. of loading surface		
Riced	1.0	2.0-3.0	A loading depth
Slices	1.0-1.3	2.0-3.0	of 2 to 4 feet is
Cubes	1.3-1.8	6.0-12.0	probably satisfac-
Strips	1.5	6.0-12.0	tory

Variations between varieties and within a single variety due to maturity, cultural conditions, or storage conditions make it necessary to determine safe operating temperatures by trial. The general principle to be followed is that the finishing temperature shall be carried as high as possible without damage to the product. To serve as a guide the following temperature conditions for different systems of dehydration are suggested for trial:

Counterflow Tunnel

	°F.
Hot-end temperature - - - - - - - - - - - -	Not over 160
Wet-bulb depression at cool end - - - - - - -	At least 25

Parallel-Flow Predrier

	°F.
Hot-end temperature - - - - - - - - - - - - - -	200-22[illegible]
Cool-end temperature - - - - - - - - - - - - -	Not over 170
Wet-bulb temperature - - - - - - - - - - - - -	Not over 120
Wet-bulb depression at cool end - - - - - - -	At least 30

Center Exhaust Tunnel

	°F.
Primary end - - - - - - - - - - - - - - - - - -	As in parallel-flow predrier
Secondary end - - - - - - - - - - - - - - - - -	As in counterflow tunnel

Conveyor-Type Drier--Through Circulation

	°F.
Primary end, first section:	
Dry-bulb temperature - - - - - - - - - - - -	180-200
Wet-bulb temperature - - - - - - - - - - - -	Not over 120
Primary end, second section:	
Dry-bulb temperature - - - - - - - - - - - -	170
Wet-bulb temperature - - - - - - - - - - - -	105
Finishing end:	
Dry-bulb temperature - - - - - - - - - - - -	160
Wet-bulb temperature - - - - - - - - - - - -	95

Bin Finishing Drier

	°F.
Dry-bulb temperature of air entering drier - - - - - - - - - - - - -	120-130 (at least 10° lower than finishing temperature in dehydrator)
Relative humidity - - - - - - - - - - - - - - -	10 percent or less

Cabinet Drier

	°F.
Starting temperature:	
Dry bulb	200
Wet bulb	Not over 120
Finishing temperature:	
Dry bulb	160
Wet bulb	95

As drying in a cabinet progresses, the dry-bulb and wet-bulb temperatures are lowered by steps until the desired finishing temperature is reached. The temperature changes are made on the basis of a time schedule previously determined by a pilot run in which the temperatures are lowered in steps as the moisture content of the product is lowered. Since moisture is lost rapidly at first, the temperature must be lowered after a relatively short time interval. Further adjustments are made after gradually lengthening intervals. Fully a half of the total drying time should be taken at the temperatures given above as finishing conditions.

Each operator will have to depend upon the method of trial and error and experience to arrive at the proper conditions. The suggestions given above on cabinet drying will supply him with a starting point for the trial-and-error investigations. It should be remembered that the conditions suggested may not in all cases give the best results.

Packaging

The packing-room equipment and methods for dehydrated sweetpotatoes are typical of those required for other dehydrated vegetables that require protection from water vapor but not from air. A picking belt for the removal of defects, a shaker screen for the removal of fines from cut sweetpotatoes, a jogging stand to increase the net weight per can or carton, and an over-and-under type of weighing scale are commonly used.

Tin cans have been replaced to some extent by 5-gallon square cartons as containers for dehydrated sweetpotatoes. The simplest equipment for these containers consists of an expanding mandrel, an overhanging shelf a little higher than a carton, a hand-operated, thermostatically controlled heat sealer, and carton assembling equipment. The product is first poured into an inner carton of chipboard. After adjustment to net weight, this carton is closed and the flaps are taped. The water-vapor protection is derived from a laminated, lead-foil bag which is opened on an expanding mandrel and slipped down over the inner carton; the "ears" of the envelope are smoothed down on the sides of the carton, and the carton and envelope are turned to bring the opening uppermost. Then the open end is flattened to a horizontal position above the overhanging shelf and the envelope is sealed with the sealing iron. The side seams are flattened; the upper ears are turned in over the top; a U-shaped piece of light chipboard is looped under the carton to protect the bottom and side seams when the filled package is placed in the outer carton. The latter is of solid weatherproof fiber and holds one 5-gallon unit.

More highly mechanized plants commonly use shakers, a suction nozzle to extract surplus air just at the time the envelope is being sealed, and a rotary heat sealer. The number of steps and the labor requirement are greater than for packaging in tin cans. A detailed description of this container can be found in the current tentative government specifications for dehydrated potatoes. Dehydrators will require between 250 and 360 5-gallon cartons for every 10 tons of raw untrimmed sweetpotatoes that are to be dehydrated.

Storage of Packaged Product

Dehydrated sweetpotatoes are relatively stable to heat, as compared with other dehydrated vegetables, and considerably more stable than white potatoes, which occupy a middle position in the scale of stability.

It is a good general rule that all vegetables should be cooled to 90°F. or lower within 24 hours after they are dried. It cannot be assumed that all of the requisite cooling will take place while the material is exposed on the picking belt. Completion of the cooling to 90°F. will take place satisfactorily after the material is packaged if the packages are kept separated. The rate of cooling will be very much slower if the cartons are stacked in a compact pile; the cooling that will occur in an isolated carton in 7 hours will require 7 days in a compact double stack, and 7 weeks in a compact stack 4 cartons thick. On the other hand, close stacking of cooled cartons in large blocks lessens the rate at which heat will be absorbed. This fact can be used to advantage when the product is in transit through warm regions. The temperature of packaged material can be taken by placing a thermometer in the center of the carton and reading after 10 minutes.

Inspection and Specifications

Purchases of dehydrated vegetables for the several government agencies are inspected by the Fruit and Vegetable Branch of the Food Distribution Administration. Processing procedures are noted and the finished product is inspected for quality according to the specifications under which the purchase is made. Certificates are issued only when inspections are made on the sealed containers representing the shipment.

In order to facilitate inspection and as a direct aid to the manufacturer certain steps should be followed. The packaged material should be coded and warehoused by coded lots. The coding can follow any system desired but should impart the following information: Product, type, year, month, day, and shift.

Representative samples are drawn at the rate of approximately 1 container per 100. The containers are checked for condition and the net weight determined by subtracting the tare weight from the gross. The entire contents are removed from the can and mixed thoroughly. A cross section is taken to make a composite sample and filled and sealed into previously dried jars. Examinations for defects, uniformity of size, presence of fines, and color of dry product can be made on the remainder and most of the material returned to the packer for repackaging.

Laboratory analyses are made to determine the moisture content, enzyme inactivation, reconstitution, and other factors as outlined in the specifications under which the product is being graded. Upon completion of the inspection the results are forwarded to the contractor and purchasing agency. Official certificates are issued and dated according to the date of the last day required to complete the anlysis. These certificates serve as a basis for payment when the merchandise is received and accepted.

Purchases are made on Quartermaster Corps Tentative Specifications, which are obtainable through the Chicago Quartermaster Corps, 1819 West Pershing Road, Chicago, Illinois, or Tentative FDA Specifications obtainable through the Fruit and Vegetable Branch of the Food Distribution Administration, U. S. Department of Agriculture.

Reconstitution and Quality

Properly dehydrated sweetpotatoes, especially the orange-colored varieties, are excellent products. The rehydrated sweetpotatoes should be sweet, free from bitter, strong, or sour taste, mild in sweetpotato flavor, and soft and tender in texture. Their color should be that of fresh, cooked sweetpotatoes of the same variety, free from dark spots and streaks. There is a tendency for the pieces to disintegrate when boiled 30 minutes, but a raw taste and flavor may result from shorter boiling.

Soaking before boiling will give a plumper product and slighly greater drained weight. Longer boiling may cause deterioration in taste, flavor, and color. Products that have been stored for some time at 90°F. may rehydrate more slowly than freshly dried material. Soaking before boiling will compensate for this more satisfactorily than will increasing the time of boiling.

The rate and effectiveness of rehydration can be determined by obtaining the drained weight of the rehydrated sample at various intervals of time and temperature of holding in water. To obtain this drained weight add to one part by weight of sliced sweetpotatoes, 6 parts of water and boil gently for 30 minutes. Drain carefully through an 8-mesh strainer for 2 minutes and weigh. The rehydrated weight should be approximately 2 to 3 times the original weight of the dried vegetable.

The vitamin content of freshly dehydrated sweetpotatoes will vary with the variety of the raw product as well as with the conditions of preparation and drying. The results of a number of tests at the Western Regional Research Laboratory indicate that in properly prepared material the following values may be taken as representative of the order of magnitude to be expected.

Vitamins in 100 grams of freshly dried sweetpotato

Thiamin	Riboflavin	Ascorbic Acid	Carotene
0.2 mg.	0.4 mg.	35 mg.	20 mg.

The caloric value of sweetpotatoes and their universal popularity give them a high rank as a dehydrated vegetable.

For further detailed information, address inquiries to the Western Regional Research Laboratory, Albany, California, or to the Bureau of Agricultural and Industrial Chemistry, U. S. Department of Agriculture, Washington, D. C.

(Certain portions of the material presented above were supplied by the Bureau of Plant Industry, Soils, and Agricultural Engineering, and Oregon State College.)